SEDIMENT EVALUATION FOR THE LOWER SYCAMORE CREEK DRAINAGE IMPROVEMENTS PROJECT

Santa Barbara, CA

July 30, 2010

CLIENT:	City of Santa Barbara
PREPARED BY:	Penfield & Smith 111 East Victoria Street Santa Barbara, California 93101 (805) 963-9532
WORK ORDER NO.:	18767.02
PROJECT MANAGER: PROJECT ENGINEER:	Craig A. Steward, P.E., CFM Michael Osborn, P.E.

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. STEWARD
No. 37253
CIVIL
STATE OF CALIFORNIA

EXHIBIT H

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOGRAPHS

APPENDICES

- HEC-RAS Summary Data
- Velocity Profile Plots
- Sediment Calculations
- Project Photographs

EXECUTIVE SUMMARY

An alternatives analysis and concept design of the Lower Sycamore Creek Drainage Improvements Project has been previously prepared and a typical channel section approved. The accepted section is trapezoidal in shape and generally extends to the edges of the Soledad Street right of way (60 feet wide.) Additionally, replacement of the bridges at Punta Gorda Street and Indio Muerto Street has been proposed. In preparation for preliminary design and environmental review, the City has commissioned Penfield & Smith, with assistance from geomorphologist Derek Booth of Stillwater Sciences, to evaluate the potential for changes in the sediment transport due to the proposed project.

Hydraulic analysis of the section of Sycamore Creek between the Santa Barbara Zoo entrance and Cacique Street was prepared using updated and more detailed topographic mapping prepared by the City of Santa Barbara. The existing creek and proposed design were modeled using HEC-RAS. Samples of channel sediments were collected and analyzed for sediment particle size.

Using the hydraulic model and sediment capacity calculation routines, various factors affecting sediment transport were estimated for the post-project condition and compared to the pre-project condition factors. The factors included:

- Average channel velocity
- Velocity distribution within a cross section
- Shear stress
- Sediment capacity

The evaluation for the post-project condition concludes:

- There will be an increase in flood conveyance approximately equal to that indicated in the concept design, improving the conveyance from about 1,100 cubic feet per second (cfs) to about 2,000 cfs.
- The sediments within the system are poorly graded sands and silty sands which begin to move within the channel at flow velocities between 1.5 feet per second (fps) and 3.0 fps.
- There will be a reduction in average flow velocity of about 1 fps and a consequent reduction in shear stresses, particularly in the reach between US 101 and Punta Gorda Street.
- Despite this reduction, the flow velocity and shear stress in the channel appear to be adequate to move the sediments currently in the channel bottom (poorly graded sands and silty sands), even during smaller runoff events.
- Design modifications were identified that will enhance the lateral continuity of sediment transport capacity along the channel. These modifications will include using a vertical curve at the grade break in the design profile (See Figure H) and reducing abrupt changes in channel section at various locations.
- Based on consultation with the project geomorphologist, this evaluation provides sufficient data to conclude that the improvements proposed for this project will have a negligible change in the long-term sediment carrying capacity within the project reach.

PURPOSE

The purpose of this analysis is to approximately identify the long-term magnitude of change (pre-project vs. post-project) in sediment capacity through the Sycamore Creek project reach. This sediment evaluation is intended to identify the magnitude of change for long-term trends in sediment transport associated with the proposed project. It will not provide an estimate of sediment transport quantities or precise locations of erosion or deposition sites. It also will not represent short-term changes in the watershed that may occur due to catastrophic events such as the Tea Fire or other events which may insert relatively short-term (over several years) increases in sediment load, necessitating short-term maintenance.
.

The physical changes anticipated from the proposed improvements include:

- Increasing the channel width;
- Grading the channel bottom;
- Replacing the existing bridges at Punta Gorda Street and Indio Muerto Street with larger bridges;
- Removing concrete lining and other manmade bank treatments; and
- Vegetating the channel banks with tree species that will form a canopy over the channel bottom.

The intent of the Lower Sycamore Creek Drainage Improvements Project is to provide the following benefits:

- Improved flood safety by conveying more creek flow during storm events;
- Enhanced vegetative and animal environment by planting the banks with trees and bushes that will shade the creek bottom and discourage plant establishment which helps maintaining sediment flow and cooling the creek water;
- Improved fish passage by removing barriers to fish movement; and
- No significant change in channel maintenance methods or frequency.

BACKGROUND

Factors that can affect the sediment capacity and flow in Sycamore Creek include:

- Supply of the sediment – This can be dramatically increased in the short-term by catastrophic events such as fires. The sediment delivery is also affected by maintenance efforts upstream of the project. For instance, if there are locations where sediment collects and is removed by governmental agencies upstream of the project, that sediment will never reach the project area.
- Geometry (including shape, slope and alignment) – The shape, bottom slope and alignment of the channel can affect the velocity of flow. For example, a very wide, shallow stream will flow slower than a compact deeper stream carrying the same quantity of flow. A steeper slope transfers potential energy (elevation) to the water as dynamic energy (velocity). The slower the water flows, the less energy is available to move sediment in the channel. The faster the water flows, the more energy is available

to pick up (erode) and carry sediment. The alignment of the channel (i.e. how many and how tight the curves are) plays a factor in the water velocity. More curves and sharper curves tend to slow water velocity and increase erosion on the outside of the curves and deposit sediments on the inside of the curves.

- Structures – Structures within the waterway can have a significant impact on sediment. Bridges that constrict the flow of water will slow the water upstream of the bridge as the water ponds up higher to push through the narrowed opening. Increased erosion then occurs within and immediately downstream of the structure due to increased velocity of water being pushing through the narrowed bridge opening. Resulting features are typically scour under the bridge and a scour hole immediately downstream of the bridge, and localized sediment deposition immediately upstream.
- Vegetation – Planting the banks with trees and bushes will protect the banks from erosion and provide shade to the creek bottom, thereby decreasing the likelihood of establishment of permanent vegetation in the creek bottom. Vegetating the sides of the channel increases the roughness of the banks and slows down water velocities. Consequently, higher velocity water is encouraged more towards the center of the channel. Therefore, through the dual approach of vegetating the sides and providing shading over the center of the channel, the bottom of the channel can be kept generally clear of vegetation. Periodic larger storm flows will then be able to more easily flush bottom sediment deposit downstream.

Photo 1 - Downstream side of Punta Gorda Street Bridge

The existing creek bottom has a slope that ranges from 0.5 percent at the lower end to 1.5 percent at the upper end. The creek bottom, where it is exposed to direct sunlight and not paved with concrete, is covered with Bermuda grass and other invasive species. There are pools and scour holes formed by eddying and manmade structures at various locations along the channel. Channel bottom width varies from 6 feet wide to 12 feet wide. The top width varies from 20 to 50 feet. The various channel bank treatments consist of sacked concrete, formed concrete, rock rip-rap, Bermuda grass, ivy and other ground cover, with occasional trees.

The bridges within the project reach are detailed in Table 1. The proposed bridges in the table below assume the implementation of a reinforced box culvert. The actual bridge type may vary depending on more detailed analysis. The opening size stated provides an approximate design conveyance capacity. Other bridge types that may be considered would need to be sized to have a similar conveyance capacity. In addition to the opening size stated, culverts/bridges will be designed to accommodate an additional two feet of depth to allow for environmental fill to enhance fish passage or otherwise have a natural bottom.

Table 1 - Bridge Sizes

Location	Pre-Project Condition[a]	Post-Project Condition[a]
Punta Gorda Bridge	Reinforced Concrete Box Culvert 21 ft wide x 7.5 ft high	Reinforced Concrete Box Culvert Double 14 ft wide by 8.5 ft high
Indio Muerto Bridge	Reinforced Concrete Box Culvert Double 8.5 ft wide x 8 ft high	Reinforced Concrete Box Culvert Double 12 ft wide x 8 ft high

[a] sizes represent open spans and do not include environmental fill.

Photo 2 - Looking downstream from Liberty Street

The post-project condition proposes a channel section that will be similar to Figure A, below. The slopes are proposed to be planted with sycamore and willow trees as well as low growing bushes and plants. It is the intent of the design to establish a tree canopy over the channel bottom, reducing grass and tulle growth. The bottom will be not be vegetated and the toe of the slope will be protected with large angular rock. The purpose of the rock is to protect the toe, to slow the flows along the edges of the creek, and reduce vegetative encroachment into the channel bottom, thus moving the faster water flow towards the middle of the channel. This both reduces slope erosion and promotes healthy sediment flow and natural creation of the thalweg.

The proposed channel bottom width for this analysis varies from 15 to 30 feet; the narrowest bottom width being a pinch point between Liberty Street and the existing property at APN 017-291-009. The remaining channel bottom width varies between about 23 feet and 30 feet.

The top width will vary from 40 feet to 80 feet (both the widest and narrowest sections occur at the curves between Liberty Street and Indio Muerto Street). The proposed channel between US101 and Liberty Street has a top width of 60 feet, being constrained by the existing Soledad Street right of way as shown in Figure A. The proposed channel between Liberty Street and Indio Muerto Street will require the acquisition of a 40 foot wide right of way as shown in Figure B.

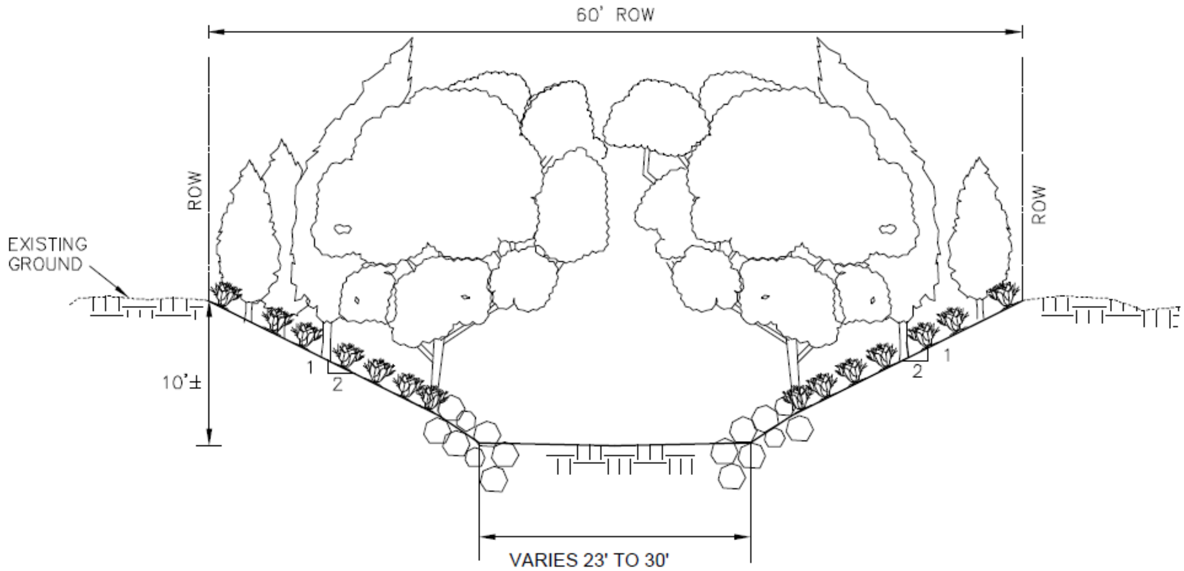


Figure A - Typical Channel Section within 60 Foot Wide Existing Road Right of Way

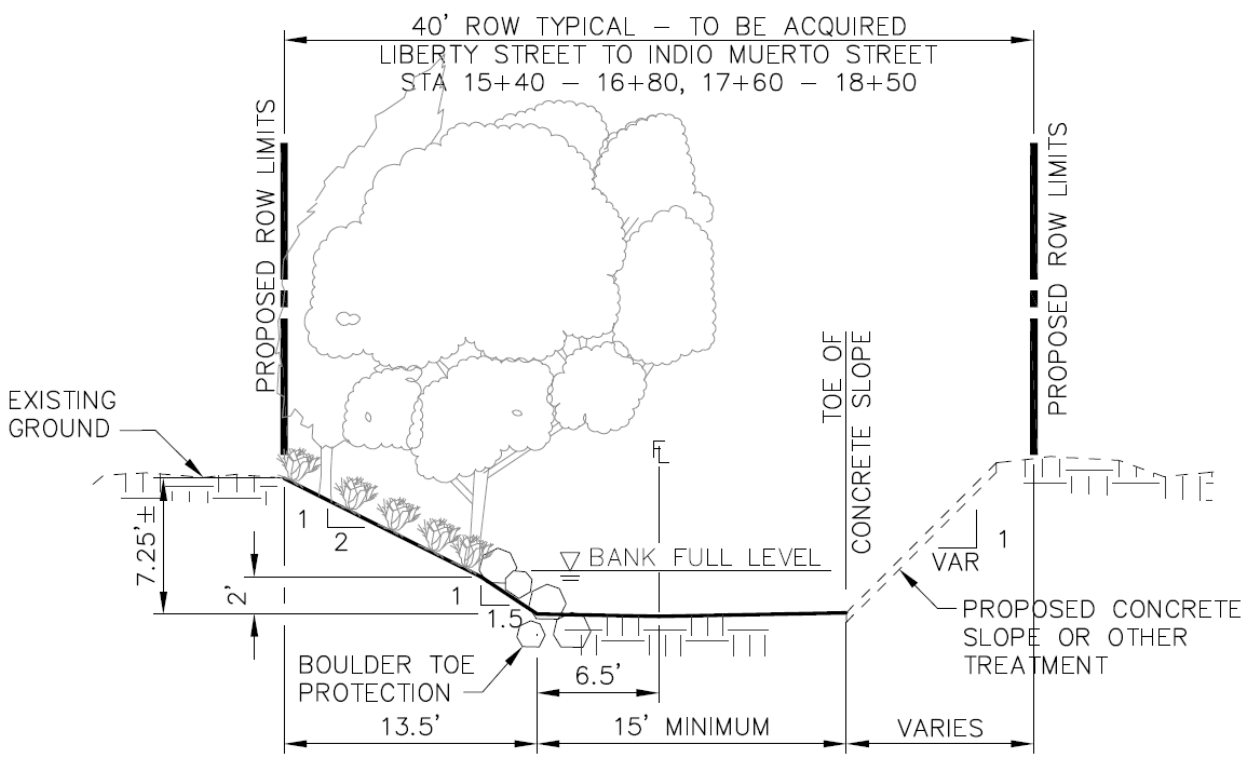


Figure B - Typical Channel Section within Proposed 40 Foot Wide Right of Way

The post-project condition of the study reach of Lower Sycamore Creek includes the new Caltrans bridge under US101 (Bridge No. 51-0332) and therefore represents a condition that has historically not existed and for which maintenance records have not been compiled. Caltrans has implemented a two phase bridge design, referred to herein as the “current” design and the “ultimate” design. The current Caltrans bridge opening is rectangular and measures 34 feet wide by 7.2 feet high, with a natural soil bottom. The ultimate design condition will remove triangular bulkheads on both sides of the current design and open up a full trapezoidal shape with a 34 foot wide bottom and a 79.1 foot wide top. Caltrans has indicated that the ultimate design condition will not be opened up until there is downstream channel capacity to accept it. For the design flows used in this report, the size of the Caltrans or other downstream bridge facilities does not significantly affect the sediment evaluation results.

CHANNEL MAINTENANCE

Recent maintenance activities in the vicinity are shown in Table 2. Besides sediment removal, maintenance activities have involved trimming and removal of trees and woody plants that are encroaching on the channel bottom. This work is accomplished by manual labor and vehicles do not enter the creek bed. Maureen Spencer, Flood Control Operations and Environmental Manager, indicates that maintenance and sediment removal within the study area of Lower Sycamore Creek is infrequent.

Table 2 - Recent Maintenance

Year	Activity	Quantity
1999, 2000, and 2001	County Programmatic EIR proposed sediment removal from Cacique Street downstream through the US101, railroad and 200 feet beyond.	Unknown quantity. Unknown if occurred.
2003-2004	Sediment removal proposed again.	Unknown quantity. Unknown if occurred.
2004-2007	No sediment removal.	
2008	Sediment removed from under US101 and railroad and about 100 feet beyond due to Tea Fire	250 cubic yards
2009	Sediment removed from under US101 and railroad and about 100 feet beyond due to Tea Fire	550 cubic yards
2010-2011	Sediment removal from under US101 and railroad and about 100 feet beyond	Proposed, see 2010/2011 Annual Routine Maintenance Plan Summary in Appendix

METHODS AND ASSUMPTIONS

The sedimentation evaluation was completed using the HEC-RAS water surface profile model, comparing pre-project and post-project conditions that could potentially affect the flow of sedimentation. This evaluation is not an exhaustive analysis of sediment transport through this reach of Sycamore Creek. It does not quantify the amount of sediment but will provide a qualitative analysis of whether the transport will increase or decrease compared to the pre-project condition. As part of the analysis, grab samples were collected and evaluated for sediment size. The locations are shown on Figure C. The sediment samples yielded the results found in Table 3. The samples are all categorized as coarse-grained soils using the Uniform Soils Classification System which is presented in Table 4. Soils of this type and that are found in this setting typically are in transit, flowing from an upstream source out to the ocean. They move when the stream is flowing at or above an average velocity of 1.5 to 3 feet per second. These velocities would likely be found when the creek is flowing “bankfull” (as defined in “Regional Curves.for Bankfull Channel Dimensions at Selected South Coast Streams”, URS

Corporation, May 2002; included in appendix.). The project geomorphologist has indicated that where the bed sediment is sand, something is probably moving almost all the time there's any flow of consequence.

Table 3 – Site Soil Classification

Sample Site	Unified Soil[1] Symbol	Typical Soil Description	D_{90}, mm	D_{84}, mm	D_{50}, mm
G-1	SP	Poorly graded sands, gravelly sands, little or no fines	0.483	0.409	0.209
G-2	SP-SM	Poorly graded sands, gravelly sands, little or no fines (SP) Silty sands, poorly graded sand-silt mixtures (SM)	0.556	0.506	0.293
G-3	SP	Poorly graded sands, gravelly sands, little or no fines	0.657	0.559	0.342
G-4	SP-SM	Poorly graded sands, gravelly sands, little or no fines (SP) Silty sands, poorly graded sand-silt mixtures (SM)	0.595	0.536	0.295
G-5	SP-SM	Poorly graded sands, gravelly sands, little or no fines (SP) Silty sands, poorly graded sand-silt mixtures (SM)	0.519	0.456	0.228
G-6	SP-SM	Poorly graded sands, gravelly sands, little or no fines (SP) Silty sands, poorly graded sand-silt mixtures (SM)	0.594	0.550	0.356

[1] Soil Mechanics; T.William Lambe, Robert V. Whitman; John Wiley & Sons, New York; 1969; Table 3.5, p 35.

Table 4 - Uniform Soil Classification System (USCS) from ASTM D 2487

Major Divisions			Group Symbol	Typical Names
Course-Grained Soils More than 50% retained on the No. 200 sieve	**Gravels** 50% or more of course fraction retained on the No. 4 sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands 50% or more of course fraction passes the No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils More than 50% passes the No. 200 sieve	**Silts and Clays** Liquid Limit 50% or less		ML	Inorganic silts, very fine sands, rock four, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays Liquid Limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils

Prefix: G = Gravel, S = Sand, M = Silt, C = Clay, O = Organic
Suffix: W = Well Graded, P = Poorly Graded, M = Silty, L = Clay, LL < 50%, H = Clay, LL > 50%

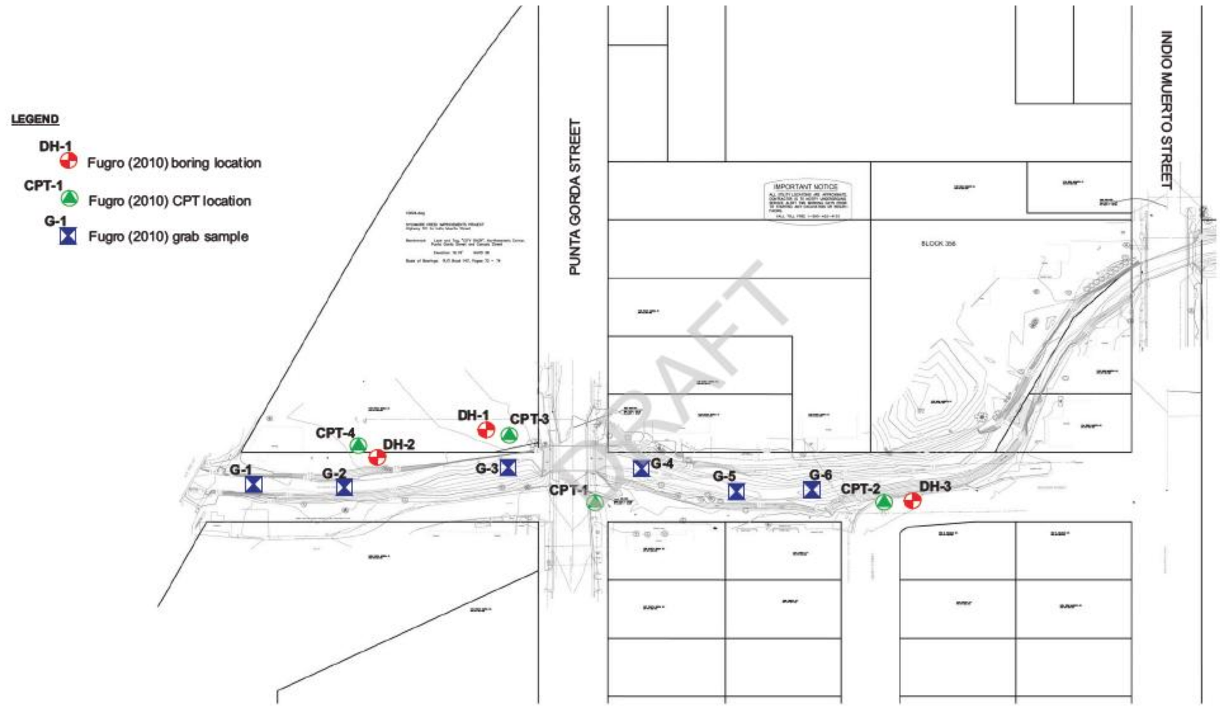


Figure C - Soil Grab Sample Locations

The analysis estimated a Manning's "n" (coefficient of channel roughness) value of 0.035 for the pre-project condition within the entire channel. For the post-project condition, a Manning's "n" value of 0.030 for the bottom and 0.040 for the banks was estimated.

The bankfull width for this stream has been estimated by URS, Inc.[2] as 19.4 feet wide and bankfull depth as 3.4 feet. The bankfull discharge ranges from 220 cubuc feet per second to 290 cubic feet per second. Bankfull width is an approximate estimate of the width of flow in a natural stream channel for an average annual storm event and bankfull depth is the depth of flow under the same conditions. Bankfull discharge is the channel flow rate at bankfull conditions. However, the project geomorphologist, Derek Booth of Stillwater Sciences, has indicated that bankfull widths and depths are not especially meaningful in characterizing the behavior of urban creeks, such as Sycamore Creek, in our climatological region. He has suggested that the sediment-transporting behavior of the channel be evaluated for flows in the range of 100 cfs to 200 cfs. This range of flows generally occurs within the creek bed annually[3] and provides the flushing action necessary to move sediment through this part of the creek system.

A comparison of the following items was prepared:

- Velocity Profile – A profile of the velocity was prepared by plotting the average velocity calculated at each cross section in the study reach. Cross sections within the study area occur at about one section for every 30 feet of channel length. This provides a visual reference to see where the water speeds up and slows down, as well as a general

[2] South Coast Streams Study; prepared by URS, Inc. for Santa Barbara County Flood Control and Water Conservation District.

[3] Based on review of recent stream gauge data in Sycamore Creek.

comparison of pre- and post-project conditions. At times the velocity varies so much that it is difficult to determine an overall conclusion. For this reason, a weighted average (velocity weighted by length of reach) of the study area was compiled.

- Velocity Distribution – Each cross section in the study area was plotted using a routine that estimates the flow velocity in various parts of the channel (rather than just an average velocity). This allows a better indication for where the sediment will be moving within the channel section.
- Shear Profile – Shear is a measure of the force of water over the sediment in the creek bed. As shear increases, the likelihood of sediment movement increases. Once sediment begins to move, less shear energy is necessary to maintain the movement.
- Water Surface Profile – The water surface profile provides visual clues as to sediment scour and deposition areas as well as locations of structures that may impact flows.
- Sediment Capacity Analysis – Using the limited amount of data available for the study area, several sediment transport equations can be applied and evaluated. The evaluation is not quantitative since estimated quantities between the various equations may vary widely, particularly without a detailed study and calibration. However, it does help to identify trends such as increasing or decreasing sediment-transport capacity.

Calculations and summary graphs are attached.

FINDINGS

Velocity Profile

Results of the Velocity Profile indicate that the velocity of low flows of storm water will be less in the post-project condition than in the pre-project condition. Table 5 illustrates the overall velocity trend and Figure B provides a velocity profile.

Table 5 - Velocity Comparison for 100 cfs and 200 cfs

Condition	V_{avg} for 100 cfs (fps)	V_{avg} for 200 cfs (fps)
Pre-Project	5.02	5.86
Post-Project	4.00	4.87
Change	-1.02	-0.99

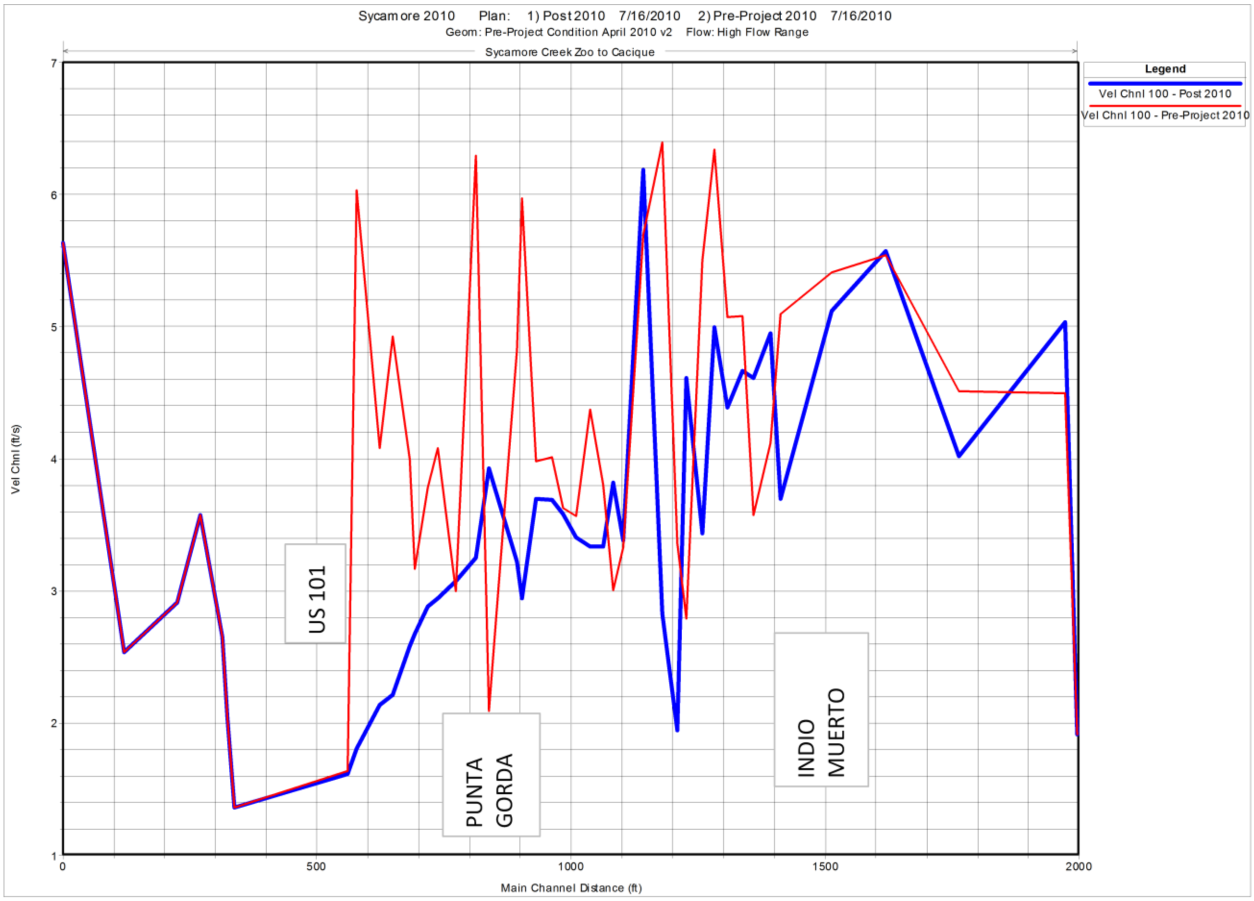


Figure D - Velocity Profile for 100 cfs

In Figure B, the blue line indicates the average pre-project velocities and the red line indicates the average post-project velocities. The horizontal axis is read with downstream to the left and upstream to the right and the velocity is shown on the vertical axis. Where there is a significant drop in velocity, it may predict a location where sediment will deposit.

Velocity Distribution

Review of the velocity distribution cross sections shown in Figures C and D, below, indicates that under the pre-project conditions, the flow velocity in the center of the channel could be expected to range from 4 to 6 feet per second while 100 cfs is flowing. Under the post-project condition with 100 cfs flowing, the velocities in the middle of the channel could be expected to flow at 4 to 5 feet per second. Velocity distribution cross sections for all cross sections are attached.

Allowable velocities for constructed waterways with sand or silty sand sediments vary between 1.5 and 3.0 feet per second[4] to be self-cleaning. Velocities above this range will tend to erode the channel[5] and velocities above 5 feet per second generally require special bank protection.

[4] Sedimentation Engineering Manual, ASCE Manuals and Reports on Engineering Practice No. 54; Table 5.2, p507.
[5] Federal Emergency Management Agency guidelines for flood protection.

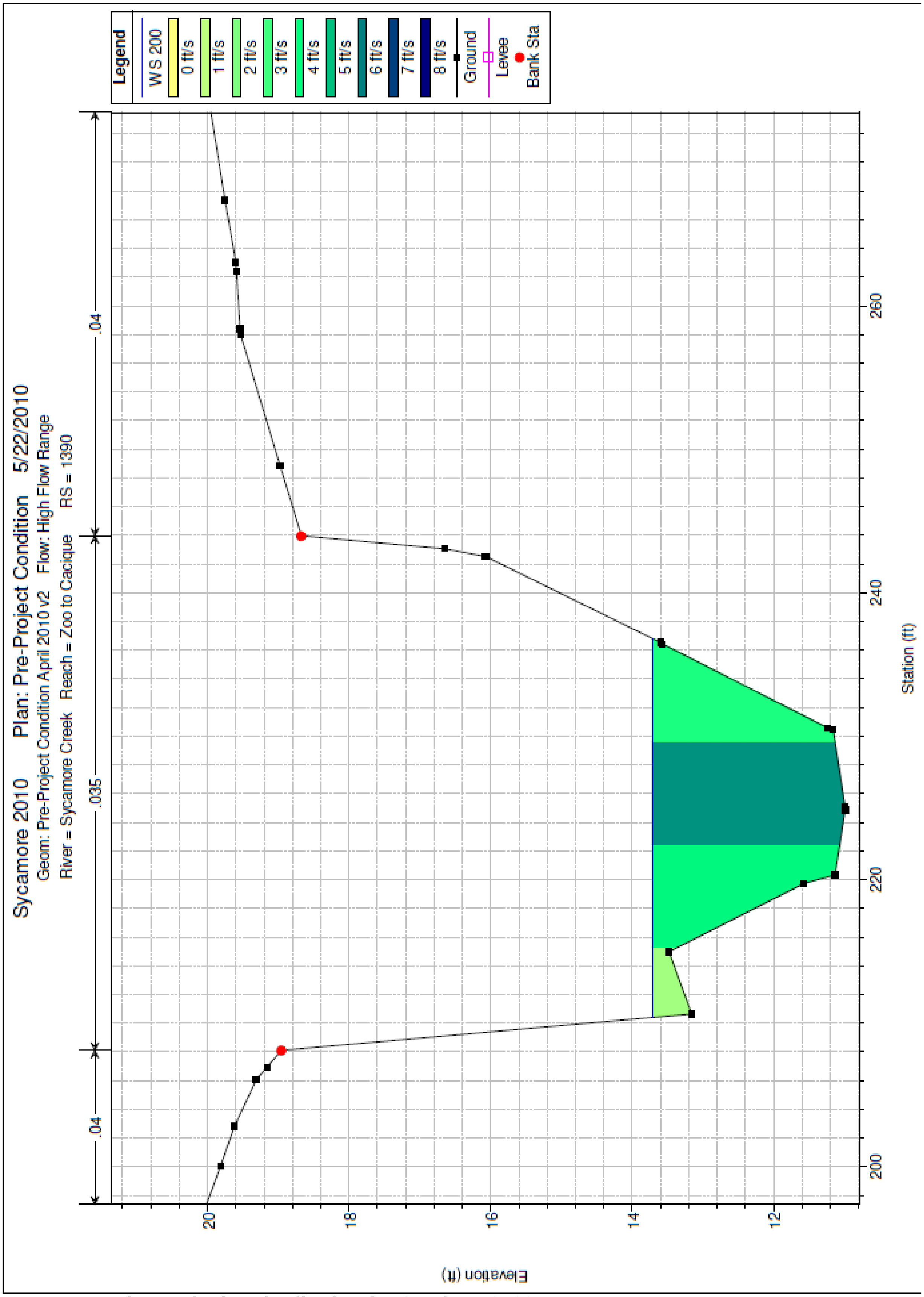


Figure E - Pre-Project Velocity Distribution for Section 13+90

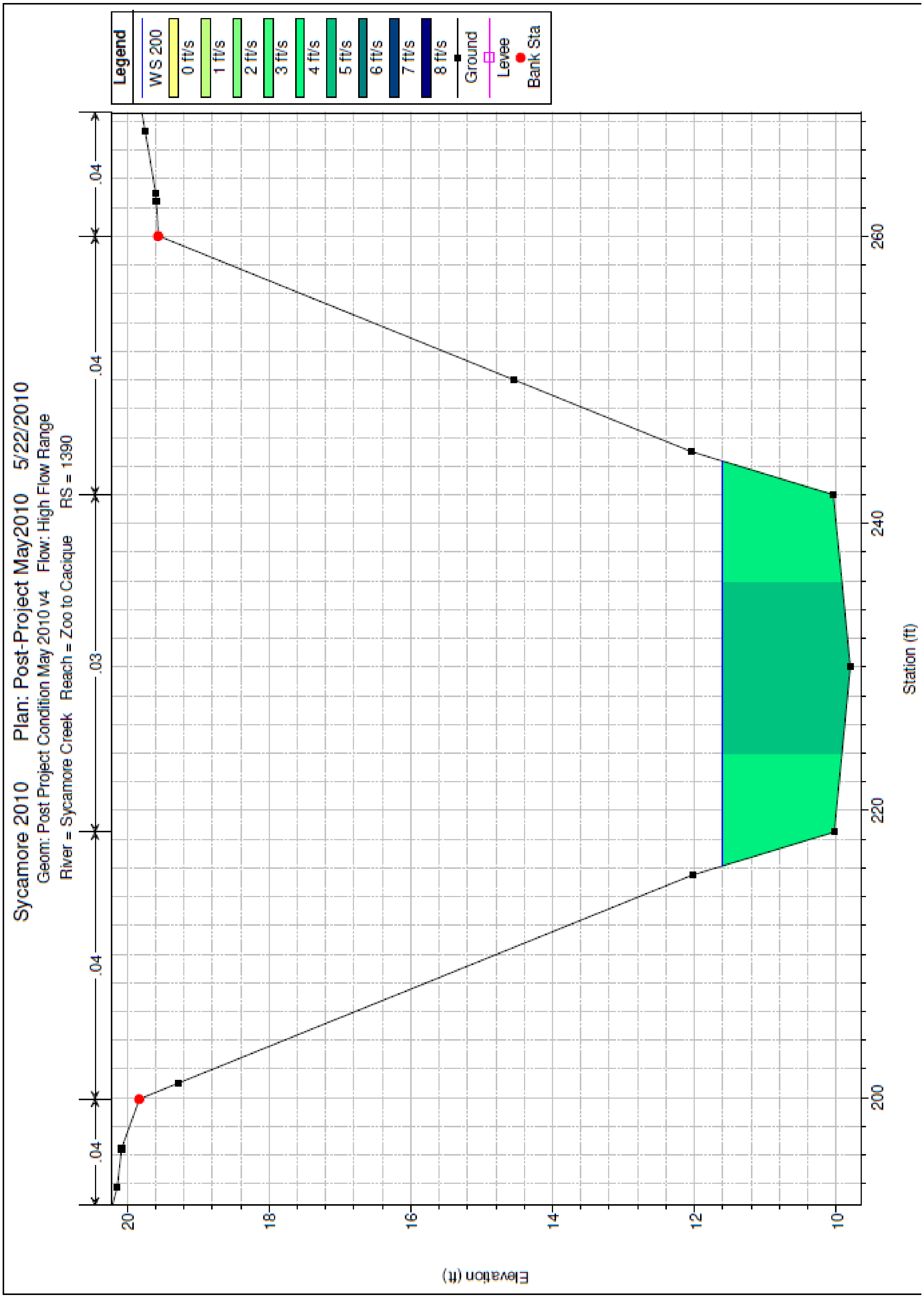


Figure F - Post-Project Velocity Distribution for Section 13+90

Shear Stress Profile

Figure E illustrates a shear profile for the project area. It shows a trend of a reduction in shear stress for the post-project condition (red line) between US101 and Punta Gorda Street compared to the pre-project condition (blue line) which indicates a gradual reduction in the ability of the water to carry the entrained sediment as it moves towards the ocean. It appears that there is a sediment sink (or place where sediment drops out) at the US101 bridge which corresponds with Flood Control sediment removal activities. Significant exceptions occur at channel distance 1100 and 1500. These locations have been identified as places where there has been a rapid and significant change in channel cross section. Review and recommendations by the project geomorphologist indicate that:

- The rapid changes in proposed channel section area should be smoothed out in order to minimize the potential for localized sediment deposition; and
- Changes in the proposed channel slope should be smoothed out by the use of a vertical curve.

These recommendations will be implemented in the 30 percent design.

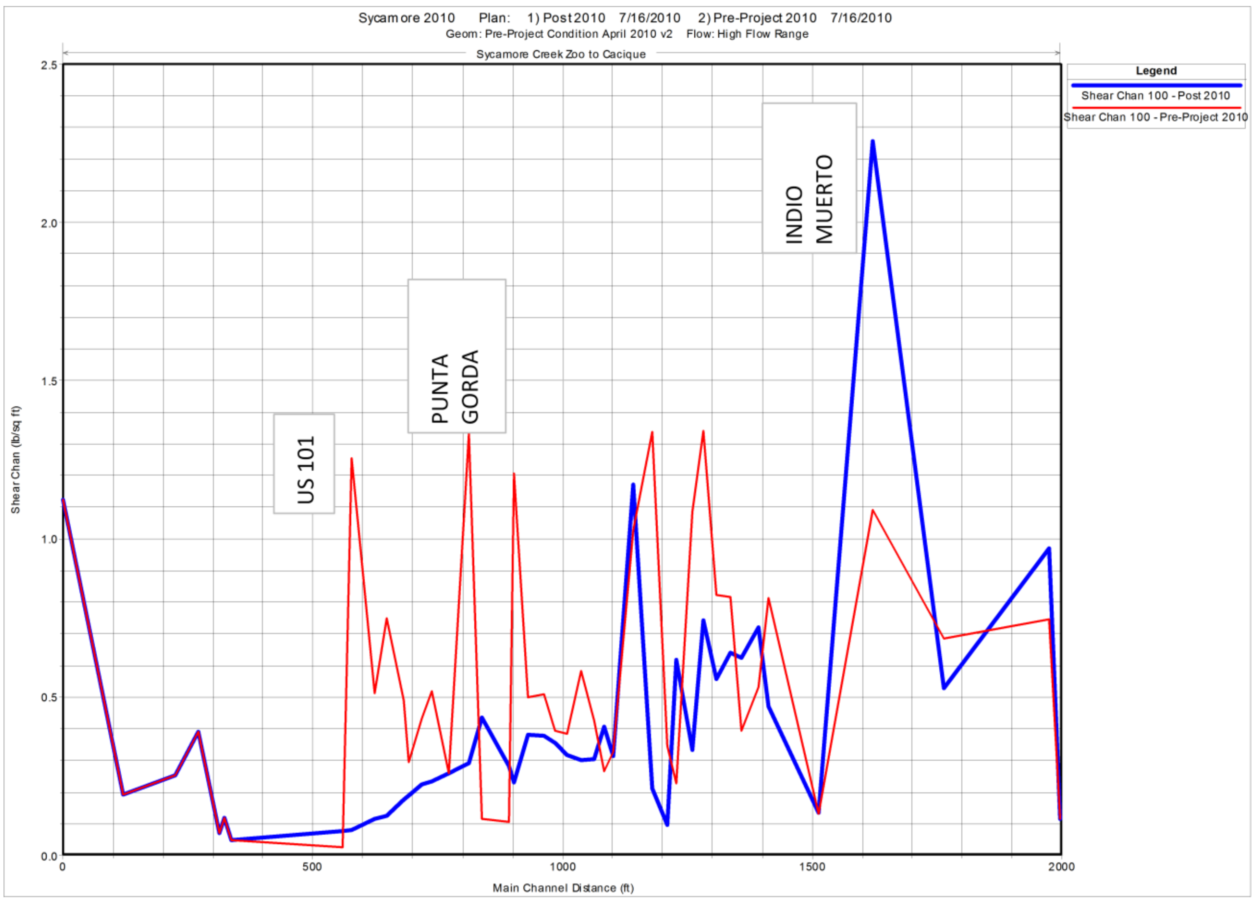


Figure G - Shear Stress Comparison for a 100 cfs flow rate

Water Surface Profile

The water surface profile in Figure H, page 15, shows how the post-project design smooths out the various scour areas and erosional features (many induced by man-made structures) while significantly reducing the water surface elevation. It appears that the reduction the flow velocity and shear stress in the channel will be adequate to move the sediments currently in the channel bottom; even during smaller runoff events.

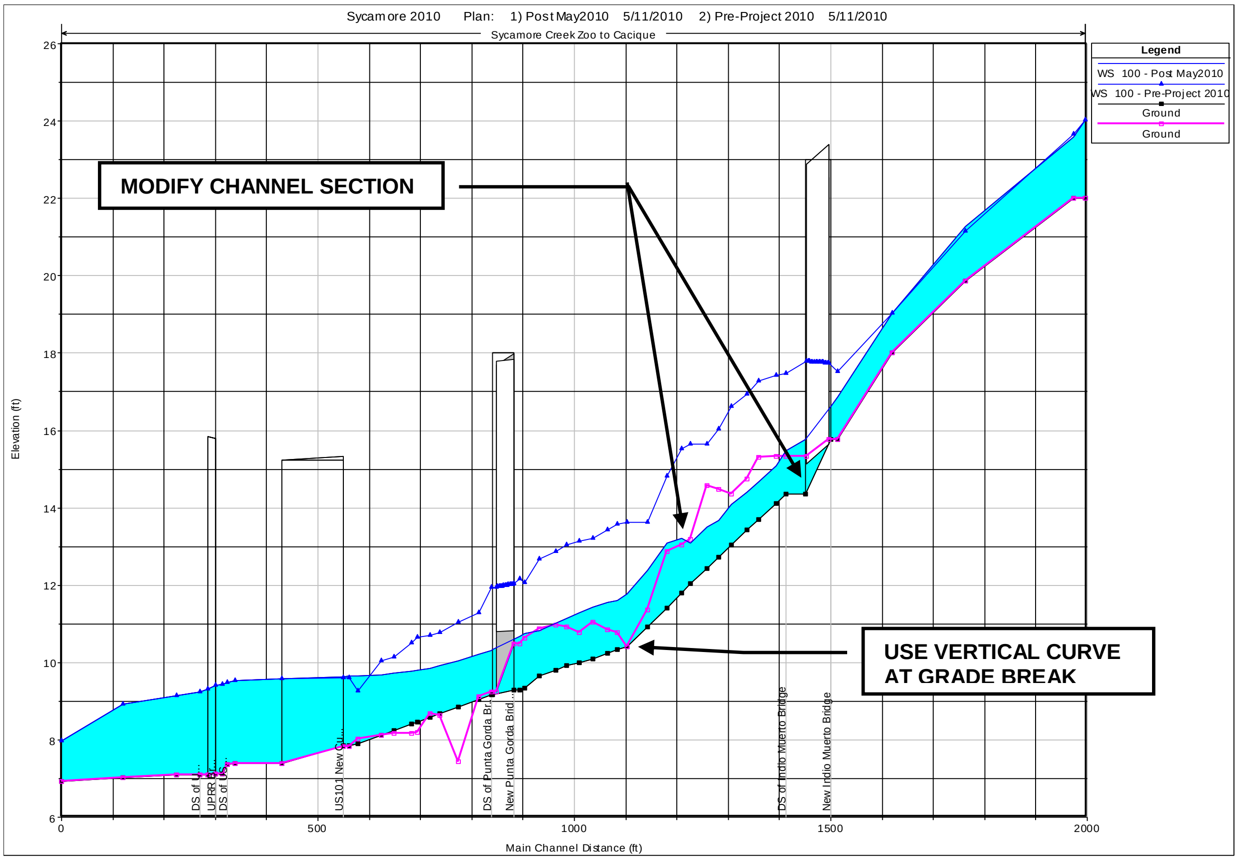


Figure H - Water Surface Profile (100 cfs)

Sediment Capacity Analysis

Sediment Capacity was evaluated using three differing methods:

- Engelund – Hansen
- Laursen (Copeland)
- Toffaleti

The authors of each of these methods derived equations by observing sediment flow under varying conditions. The conditions under which they were derived were compared to the Sycamore Creek field conditions and found to be the methods that best agreed with the test conditions. Table 6 compares these conditions.

Table 6 - Sediment Transport Variable Comparisons

Description	Engelund - Hansen	Laursen (Copeland)		Toffaleti		Sycamore Creek
Experiment Type	Flume	Field	Flume	Field	Flume	na
Prediction Type	Total load	Total load	Total load	Total load	Total load	na
d, overall particle diameter mm	na	na	na	0.062 < d < 4	0.062 < d < 4	na
dm, median particle diameter mm	0.19 < dm < 0.93	0.08 < dm < 0.7	0.011 < dm < 29	0.095 < dm < 0.76	0.45 < dm < 0.91	0.209< D_{50} <0.356
V, average channel velocity fps	0.65 < V < 6.34	0.068 < V < 7.8	0.7 < V < 9.4	0.7 < V < 7.8	0.7 < V < 6.3	4.00 < V < 5.86
D, channel depth ft	0.19 < D < 1.33	0.67 < D < 54	0.03 < D < 3.6	na	Na	0.86 < D < 4.56
R, hydraulic radius ft	na	na	na	0.07 < R < 56.7	0.07 < R < 1.1	0.74 < R < 2.16
S, energy gradient ft/ft	0.000055<S<0.019	0.0000021<S<0.0018	0.00025<S<0.025	0.000002<S<0.0011	0.00014<S<0.019	0.000215<S<0.039215
W, channel width ft	na	63 < W < 3640	0.25 < W < 6.6	63 < W < 3640	0.8 < W < 8	13.5 < W < 58
T, temperature degrees F	45 < T < 93	32 < T < 93 degrees	46 < T < 83	40 < T < 93	32 < T < 94	na

Although none of the conditions under which the sediment transport equations were tested is a perfect fit for the Sycamore Creek conditions, each of these methods indicate a reduction in sediment capacity in the channel between US 101 and Punta Gorda Street. The actual results vary significantly from each other and are not very meaningful for this level of study other than to identify trends (ie, that the post-project sediment capacity is reduced compared to the pre-project sediment capacity). This is consistant with the results of the velocity and shear stress analyses.

During larger storms or after a fire, the nature of the sediment load and locations of deposition is likely to change. Finer sediments may be deposited temporarily until flushed out with subsequent storms or channel maintenance may be required to maintain the expected flow capacity for future flood events. When the channel capacity is exceeded, finer sediments will be carried and deposited in the adjacent streets and yards. This type of transport and deposition is not evaluated in this report.

CONCLUSIONS

For the post-project condition with the proposed trapezoidal cross section:

- There will be an increase in flood conveyance approximately equal to that indicated in the concept design.
- The sediments within the system are poorly graded sands and silty sands which begin to move within the channel at flow velocities between 1.5 feet per second (fps) and 3.0 fps.
- There will be a reduction in average flow velocity of about 1 fps and a consequent reduction in shear stresses, particularly in the reach between US 101 and Punta Gorda Street.
- Despite this reduction, the flow velocity and shear stress in the channel appear to be adequate to move the sediments currently in the channel bottom (poorly graded sands and silty sands); even during smaller runoff events.
- Design modifications were identified that will enhance the lateral continuity of sediment transport capacity along the channel. These modifications will include using a vertical curve at the grade break in the design profile and reducing abrupt changes in channel section at various locations.
- Based on consultation with the project geomorphologist, this evaluation provides sufficient data to conclude that the improvements proposed for this project will have a negligible change in the long-term sediment carrying capacity within the project reach.

APPENDICES

- HEC-RAS Summary Data
- Velocity Profile Plots
- Sediment Calculations
- Project Photographs

ADDENDUM TO

SEDIMENT EVALUATION FOR THE LOWER SYCAMORE CREEK DRAINAGE IMPROVEMENTS PROJECT

Santa Barbara, CA

January 3, 2011

CLIENT: City of Santa Barbara

PREPARED BY: Penfield & Smith
111 East Victoria Street
Santa Barbara, California 93101
(805) 963-9532

WORK ORDER NO.: 18767.02

PROJECT MANAGER: Craig A. Steward, P.E., CFM
PROJECT ENGINEER: Michael Osborn, P.E.

PURPOSE

This addendum has been prepared after review of comments from the Development Application Review Team (DART) dated August 14, 2010. Based on these comments and long-term funding expectations, additional explanation and changes to the Sedimentation Evaluation for the Lower Sycamore Creek Improvements Project have been made. This addendum addresses those items.

SCOPE OF PROJECT

The original scope of the proposed project extended from the northerly US101 right of way at Sycamore Creek to about 50 feet upstream of the Indio Muerto Bridge. The scope of the proposed project has been modified to start at five (5) feet north of the US101 right of way and extends just upstream to Punta Gorda Street. No work is proposed to occur within the Caltrans or Union Pacific Railroad right-of-ways. Within this revised project scope, the project will be divided into two phases:

Phase 1 – from 5 feet north of the US101 right of way at Sycamore Creek, upstream within the Soledad Street right of way to 100 to 150 feet south of the Punta Gorda Street Bridge. Improvements are limited to channel construction and associated work.

Phase 2 – from 100 to 150 feet south of the Punta Gorda Street Bridge to 55 to 75 feet north of the Punta Gorda Street Bridge. Improvements include channel improvements, replacement of the existing Punta Gorda Street Bridge with a Conspan Bridge, transitions, and associated work.

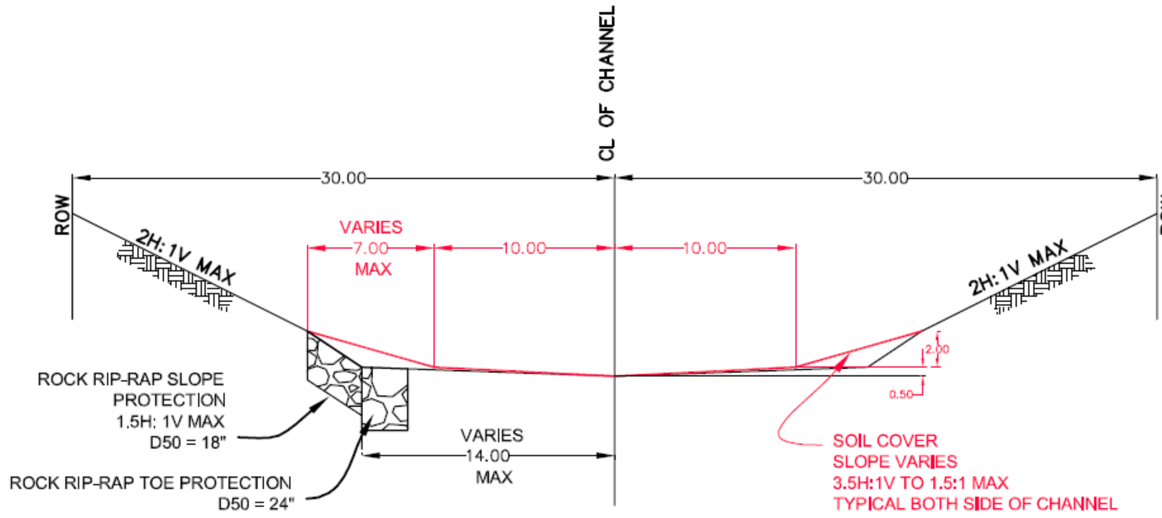
CHANGES IN DESIGN

Channel Section

In response to DART comments, the channel section has been modified to more closely reflect Santa Barbara County Flood Control maintenance operations. The bottom width is revised from 28 feet to 20 feet by inserting a variable wedge of soil between the top of the proposed rock rip-rap toe protection and the new toe location (10 feet from the center of the channel). See Figure A.

Punta Gorda Street Bridge

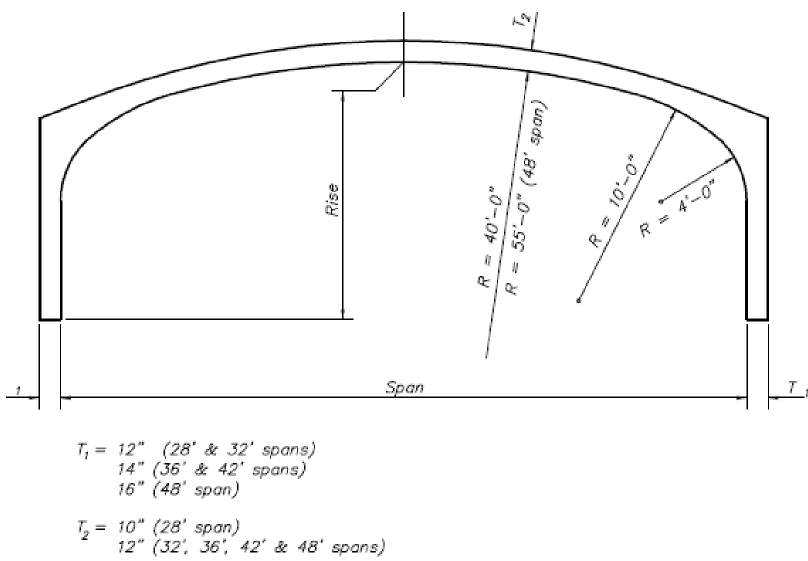
In response to DART comments, the reinforced concrete box culvert with soil covered bottom has been replaced with a precast reinforced concrete Conspan bridge (28’ span, 9’ rise) and wingwalls. The bridge type modification fits the modified channel width, provides a natural soil channel bottom, allows enhanced fish passage, and minimizes potential scour at channel forming flow rates. See Figure B.



NOTES:

- ROCK RIP-RAP PROTECTION TYPICAL OF BOTH SIDE OF CHANNEL
- MODIFIED ITEMS ARE INDICATED IN RED

Figure A - Revised Channel Cross Section



WATERWAY AREA (SQUARE FEET)					
RISE (FT.)	SPAN (FT.)				
	28	32	36	42 **	48
8	195	216	*	*	*
9	223	248	268	*	*
10	251	280	304	334	*
11	279	312	340	376	435
12	*	344	376	418	483
13	*	*	412	460	*
14	*	*	*	502	*

** Note: Geometry may vary slightly depending upon location of production, call CON/SPAN for details.

LONG SPAN SERIES

*Contact local provider for more information regarding this Span and Rise combination.

CON/SPAN® BRIDGE SYSTEMS

Revised 4/10/03

Figure B - Revised Bridge 28' Span, 9' Rise

IMPACTS OF MODIFICATIONS ON ORIGINAL REPORT FINDINGS

Change in Scope of Project

The reduction to the scope of the proposed project will not significantly change the findings of the Sedimentation Evaluation within the area of the proposed construction. The original report remains viable and useful for future projects outside of the revised project scope.

Change in Channel Section

The modification of the channel section has very minor impact on the sediment transport findings in the Sediment Evaluation, increasing the average velocity during channel forming flows by about 0.5 feet per second. The increase average velocity will slightly increase the sediment transport capability.

Change in Bridge Type

The modification of the type and size of bridge has a negligible impact on sediment transport at channel forming flow rates. There will be a slight decrease in flow capacity at the upper end of the channel capacity rating (2,000 cfs) exhibited by an average increase of 3 inches in water depth within in the first 75 feet upstream of the Punta Gorda Bridge.

Penfield & Smith
Engineering • Surveying • Planning • Construction Management

111 East Victoria Street • Santa Barbara, CA 93101
tel 805-963-9532 • fax 805-966-9801

M E M O R A N D U M

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. STEWARD
No. 37253
CIVIL
STATE OF CALIFORNIA

TO:	City of Santa Barbara, Public Works
FROM:	Craig A. Steward, P.E., CFM
SUBJECT:	Sycamore Creek Future Maintenance
WORK ORDER:	18767.02
DATE:	August 3, 2011

Based on the Sedimentation Evaluation prepared by Penfield & Smith dated July 10, 2010 and updates, Penfield & Smith concurs with Santa Barbara County Flood Control District Operations and Maintenance Manager Maureen Spencer that there will be no change to the maintenance procedures or frequency in Lower Sycamore Creek due to the proposed channel and bridge improvements in Sycamore Creek between US101 and Liberty Street.